

SCREEN PRINTING SQUEEGEE FOR APPLYING SOLDER PASTE

Field of the Invention

[0001] This invention relates generally to apparatus and methods of
5 manufacturing and using a squeegee apparatus with machinery for applying
solder paste to circuit connections, and more specifically, a method and
apparatus for mounting the squeegee blade such that all four long edges are
available for use instead of the typical two edges. The invention further relates to
a method of setting up and aligning the squeegee blade to avoid errors due to
10 deformation caused by clamping forces used to mount the resilient squeegee
blade (typically made of rubber).

Background of the Invention

[0002] Electrical connections between circuit components and a PCB (printed
15 circuit board) or integrated circuit substrate are typically made by solder ball
connections or by dipping the side of a board into molten solder. The PCB in
combination with a screen mask or stencil is typically placed connector or back
side up such that only related connections are exposed by the stencil or screen
mask. The combination PCB and screen mask is placed on a machine such as a
20 MicroStar BGA Solder Ball Attaching Machine. The machine then provides a
selected volume of solder paste at one edge of the PCB in front of the squeegee
apparatus. The squeegee apparatus is then placed so as to contact the PCB
before it is moved across the PCB. As the squeegee moves across the PCB, it

evenly distributes solder paste through apertures in the screen mask or stencil to the exposed connection points. Thus, the apertures assure that the selected connections will be coated by solder paste before they receive solder. To assure even distribution of the solder paste, the squeegee blade must be carefully

5 aligned so that the squeegee edge contacting the PCB is parallel to the surface of the PCB. Since a straight and undamaged squeegee edge is necessary to assure the even distribution of the solder paste, the squeegee blade is frequently replaced and/or reoriented such that a new and undamaged edge is available. Further, since the squeegee blade is typically made of a resilient rubber, mounting of the squeegee blade must be accomplished with extreme care to 10 assure that the edge of the squeegee blade that will contact the PCB is parallel to the PCB. In addition, prior art methods of mounting the squeegee blade typically require attaching the blade to holding apparatus by a plurality of bolts. However, the bolts must be carefully torqued or tightened to avoid deforming the 15 rubber due to unequal pressure being applied by the plurality of bolts. Finally, significant amounts of solder paste may be wasted if it is allowed to flow around the ends of the squeegee and beyond the PCB.

Summary of the Invention

20 [0003] One embodiment of the present invention provides method and apparatus for simplifying the mounting procedures to ensure a properly aligned edge of a squeegee blade and which also doubles the number of edges of the squeegee

blade available for use. Another embodiment incorporates over flow end guards to prevent excess solder paste from running around the squeegee ends.

[0004] According to the present invention, there is provided methods and apparatus for applying solder paste to circuit connections comprising a squeegee

5 blade having a pair of elongated face sides spaced apart by a selected thickness and a pair of elongated substantially parallel narrow sides spaced apart by a selected width. The elongated face sides and the elongated narrow sides join together at a squeegee operating edge. There is also included a slightly resilient clamping structure defining an elongated rectangular cavity for receiving the
10 squeegee blade. The cavity has a depth less than the selected width of the squeegee blade's first and second longer sides which are separated by a short dimension which is less than the selected thickness of the squeegee blade.

Consequently, the clamping structure can apply a gripping force to the squeegee blade when the blade is received within the cavity. Also included is a plurality of
15 fasteners, such as threaded bolts, received by the clamping structure for adjusting the gripping force applied to the squeegee blade to hold the blade firmly into the clamping structure. Unlike the prior art squeegee blades, the squeegee blade of this invention is free of mounting apertures and consequently, each squeegee blade may be oriented such that there are four available edges to
20 provide the squeegee action. Another embodiment of the apparatus further includes solder paste overflow guards which are located at each end of the squeegee blade and perpendicular to the squeegee blade such that solder paste cannot flow beyond the edges of the circuits and be wasted.

Brief Description of the Drawings

[0005] Figure 1 is a schematic or skeleton illustration of a squeegee apparatus for applying solder paste to circuit connections.

5 [0006] Figure 2 is a cross-sectional illustration showing a squeegee operation of applying solder paste through a screen mask or template to selected circuit connections.

[0007] Figure 3A is a side view and Figure 3B is a front view of prior art squeegee apparatus.

10 [0008] Figure 4 is an oblique view of the prior art squeegee blade of Figures 3A and 3B.

[0009] Figure 5A is a side view and Figure 5B is a front view of one embodiment of the squeegee apparatus of the present invention.

[0010] Figure 6 is an oblique view of the squeegee blade of the squeegee apparatus of the present invention shown in Figures 5A and 5B.

15 [0011] Figure 7 illustrates another embodiment of the present invention further including side guards to prevent the loss of excess solder.

Description of Preferred Embodiments

20 [0012] Referring now to Figure 1, there is shown a schematic view of an apparatus for applying paste to connections on circuit boards which are to be electrically connected by solder. As shown, the apparatus will include a machine bed 10 for supporting at least one printed circuit board or integrated circuit 12. Squeegee apparatus 20 is supported by holding or support apparatus 22 which

moves the squeegee apparatus 20 from a first end 24 of the machine bed 10 to an opposite end 26 of the machine bed. In operation, solder is introduced in front of the squeegee blade and then the squeegee blade is dragged across one or more printed circuit boards or integrated circuits such as integrated circuits 12,

5 14, 16 and 18 so as to evenly distribute the solder paste across the circuit boards. The solder paste has been applied to PCB 12 as indicated by the solid connections 21. The solder paste has been applied to some of the connections on PCB 14 as indicated by solid connection 21, but not to others as indicated by the empty circuit 21a. Solder paste has not been applied to any of the
10 connections on PCBs 16 and 18 as indicated by all of the connections being open as indicated by 21a.

[0013] Referring now to Figure 2, there is shown an enlarged schematic of the squeegee blade 20 as it moves across the printed circuit board 14 as indicated by arrow 23. As shown, there is also included a mask screen or stencil 28 which
15 includes apertures, such as aperture 30, which expose areas or connection points on the printed circuit board 14 where solder is to be used for making an electrical connection. As shown, the squeegee edge 32 is dragged or passes over the screen mask or stencil 28 and moves a roll of solder paste 34 across the screen mask 28. In those areas of a circuit board where there are no apertures,
20 such as aperture 30, the squeegee edge 32 of squeegee 20 will typically wipe the screen mask or stencil 28 to clean off the solder paste 34. However, where apertures exist, the solder paste will be forced down into the aperture 30 to provide a coating of the solder paste in those connection areas of the circuit

exposed by the stencil 28. Thus, it will be appreciated that the solder paste 34 will only be deposited where a connection is to be made as provided for by the screen mask or stencil. It should also be understood that although there is only a single aperture 30 that has been shown in Figure 2, there typically will be a plurality (tens or hundreds) of such apertures on a circuit board which receives the solder paste as is better indicated by the connections 21 and 21a of Figure 1.

[0014] Referring now to Figures 3A and 3B, there is shown a side view and a front view, respectively, of a prior art squeegee apparatus. As shown, there is a clamping portion 36 typically mounted to the holding apparatus 22 shown in

Figure 1 by a bolt or mounting rod indicated at reference number 38. The clamping portion 36 typically includes a ledge or cut-out area 40 for receiving a squeegee blade 42 as shown in Figures 3A and 3B. A perforated metal strip 44 shown in the left most portion of Figure 3B or individual washers 45 receive threaded bolts 46 which are received by threaded apertures 48 in the clamping portion 36 as shown in Figure 3A. Figure 4 shows a prior art squeegee blade 42, including a series of mounting apertures 50a through 50h, that allows for the bolts 46 which pass through the perforated strip 44 and for washer 45 to also pass through the apertures 50a through 50h into the threaded aperture 48 of metal clamping portion 36 of the apparatus. Thus, referring to Figure 3A, it can be seen that if the combination clamping structure 36 and squeegee blade 42 are moved in the direction as indicated by arrow 52, the edge 54 of squeegee blade 42, which is in the front or forward position, will bear against the screen mask as it moves across the one or more circuit boards and evenly distributes the solder

paste. Referring to Figure 4, it is seen that there are two possible useable edges 54 and 56 for distributing the solder paste. For example, if edge 54 becomes damaged or worn, edge 56 may be used as the contact or front edge by removing squeegee blade 42 from the clamping apparatus 36 and flipping the blade 42 over (180°). The edges 58 and 60 at the top of the solder blade 42 typically are not available for use as squeegee edges because of the mounting apertures 50a through 50h.

[0015] It will also be appreciated by those skilled in the art that the mounting bolts 46 used to clamp squeegee blade 42 to the clamping structure 36 must be carefully tightened or torqued to avoid distortion of the resilient rubber material used in the squeegee blade 42. As will be appreciated by those skilled in the art, if a bolt 46 is tightened an excessive amount, the rubber will deform and may likely cause a protrusion or uneven area at the squeegee edge which contacts the screen mask and thereby makes it impossible to evenly distribute the solder paste. Such an uneven edge may result in such uneven distribution that a gap is formed such that solder paste passes under the blade edge and is not moved across the face of the screen mask.

[0016] Finally, it will be appreciated that excessive solder paste indicated at reference numeral 62 in Figure 3B accumulating in front of the edge 54 of squeegee blade 42, may run around ends 64 and 66 and beyond the edges of the printed circuit boards such that it is not useable and will be wasted.

[0017] Referring now to side view Figure 5A and front view Figure 5B, there is shown the squeegee apparatus of the present invention. As shown, there is

again included a squeegee blade 42A mounted to clamping apparatus 36A.

However, as is clear, mounting apparatus and squeegee blades 42A include significant changes and improvements over the prior art apparatus. As shown, clamping apparatus 36A is constructed from a partially resilient material, such as

5 for example, hard rubber, and includes a backing portion 68 and a front or clamping portion 70. Backing portion 68 and clamping portion 70 comprising clamping apparatus 36A are typically two separate pieces or portions, but as shown, could be molded with a thin flexible rubber hinge 72. The backing portion 68 and clamping portion 70 define an elongated rectangular cavity 74 for

10 receiving the squeegee blade 42A. As seen, the backing portion 68 also includes an extension 76 which provides backing support to the more flexible squeegee blade 42A when the squeegee apparatus with blade 42A is moved in the direction as indicated by arrow 78. The front or clamping portion 70 of the clamping apparatus 36A defines a series of apertures 80a through which

15 threaded mounting bolts 82 pass and are received in matching apertures 80b of backing portion 68 such that a clamping force can be provided to secure the squeegee blade 42A within the cavity 74 discussed above. Threaded inserts 84 may be included within the apertures 80b of the backing portion 68 for receiving the threaded bolts 82. Front or clamping portion 70 further typically includes a lip

20 portion 86 which bears against the full length of the squeegee blade 42A to assure sufficient clamping force to maintain the squeegee blade in position. In addition, the partially resilient clamping apparatus allows its mounting bolts to simply be tightened down without having to carefully torque its bolts. Also as

shown, the new clamping structure 36A of the present invention further includes expansion spaces 88a and 88b to relieve distortion of the resilient squeegee blade 42A.

[0018] Referring now to Figure 6, there is illustrated the squeegee blade 42A of

5 the present invention. As shown, the squeegee blade 42A of Figure 6 is free of mounting holes which were necessary for the prior art mounting technique discussed with respect to the squeegee blade shown in Figure 4. Consequently, in addition to the two edges 54A and 56A shown in Figure 6, which are available for use for squeegee operation or activity, the present blade may also be rotated
10 such that the squeegee blade edges 58A and 60A are available for use. Thus, it will be appreciated that the present invention allows or provides twice the number of available squeegee blade edges for use in squeegee operations. Further, by using the hard rubber mounting structure 36A, the clamping forces can be more easily controlled and thereby avoid areas of excess pressure which will tend to
15 distort or deform the squeegee edges used to contact the screen mask. Further, the expansion spaces 88a and 88b as illustrated in Figure 5A allow some expansion of the top edges to further relieve excess pressure and deformation.

[0019] Referring now to Figure 7, there is shown a further embodiment of the present invention. As shown, in addition to the improved squeegee blade

20 apparatus 36A as discussed above, the embodiment of Figure 7 further includes a pair of over flow guard members 90 mounted at each end of the squeegee blade apparatus so as to prevent the excess overflow of solder paste around the ends of the squeegee blade, such as shown at 64A. The over flow guards 90

may be mounted to either the squeegee clamping apparatus 36A or to the holding apparatus 22 shown in Figure 1 which supports the squeegee apparatus.

[0020] Thus, there has been described unique apparatus and methods of this invention for applying solder paste by the use of squeegee blades which

5 methods and apparatus doubles the number of available squeegee edges on a squeegee blade and also helps eliminate distortion or deformation of the squeegee blade to assure a regular undamaged and aligned squeegee blade edge is in contact with a circuit screen mask or stencil. Further, although the invention has been described with respect to specific methods and apparatus, it

10 is not intended that such specific references be considered limitations upon the scope of the invention except as is set forth in the following claims.